

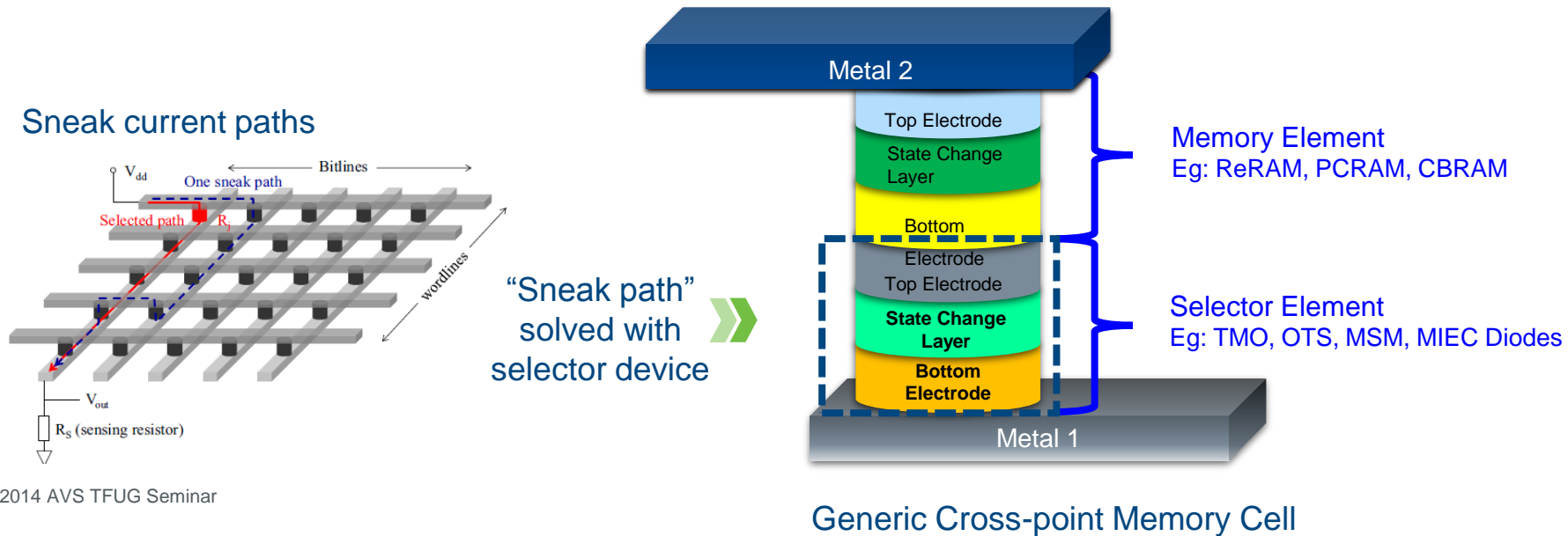


# **3D XPoint: Current Applications and Device Innovation**

August 8, 2017

# 3D Cross-point Memory – Selector Case Studies

## Challenges with Sneak Current Paths for 3D Cross-point Memory

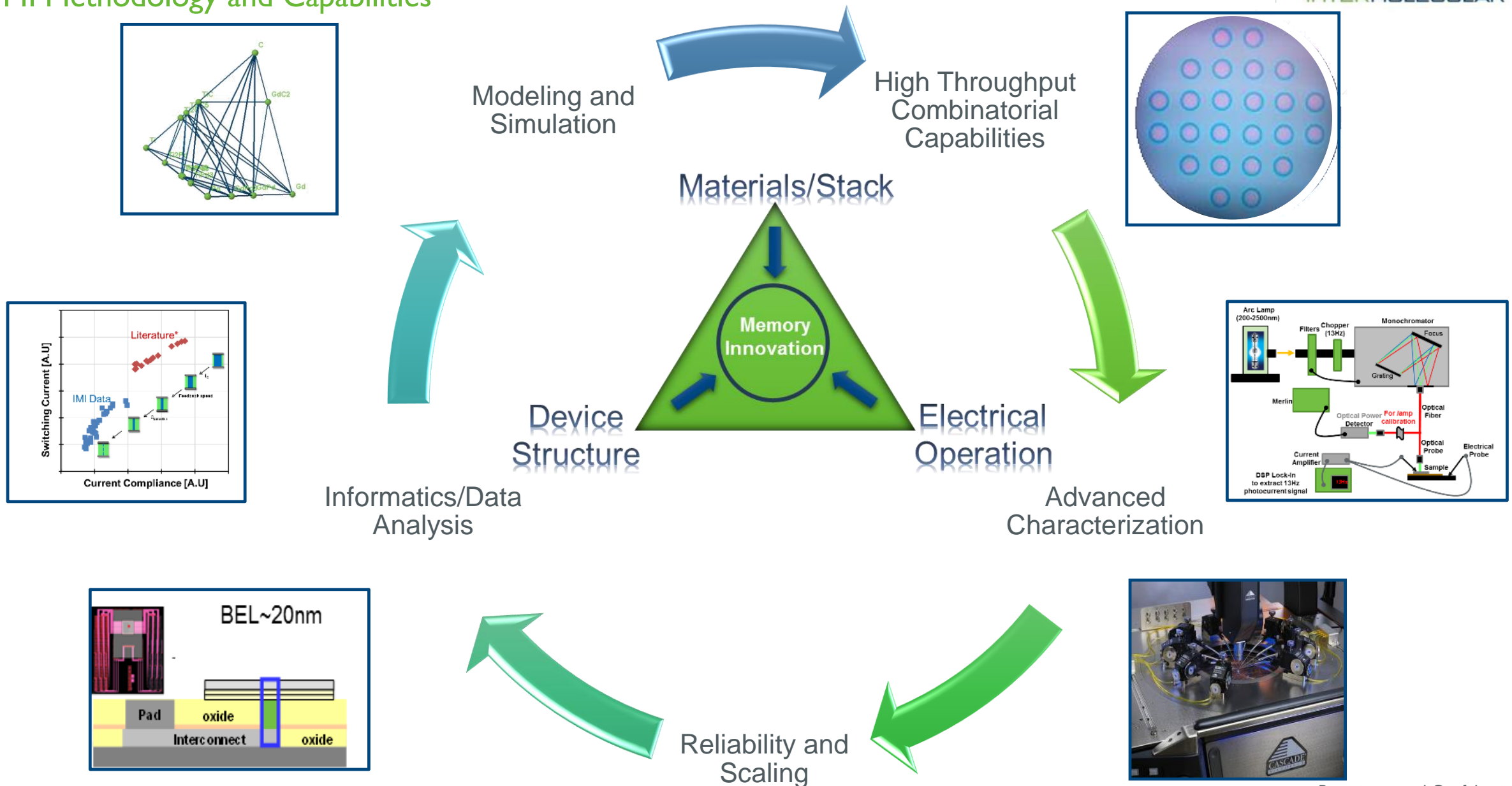


\* Ref: An Chen 2014 AVS TFUG Seminar

- ❑ Selector devices are critical to eliminating sneak current paths
- ❑ Disruptive selectors needed to address performance, density and reliability requirements

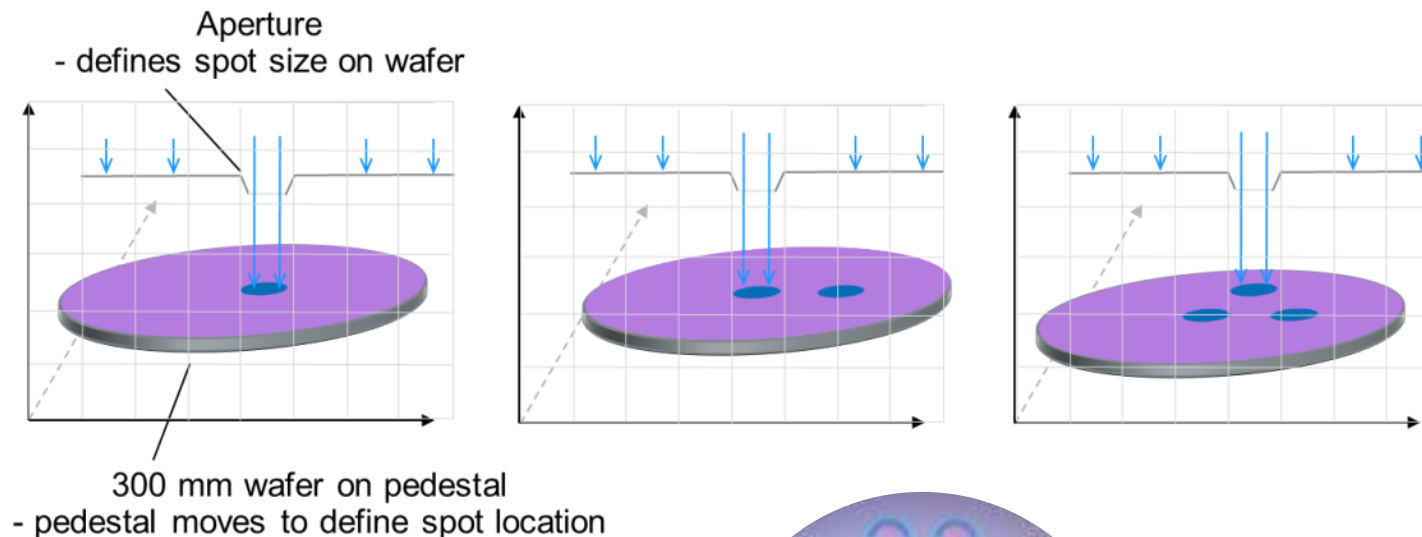
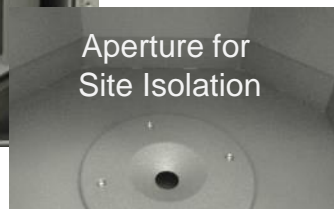
# Memory Materials and Device Innovation Needs:

IMI Methodology and Capabilities



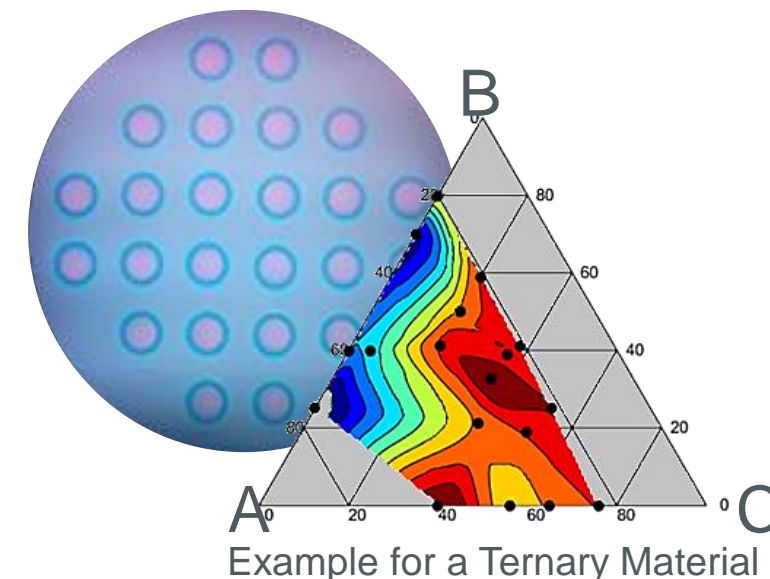
# PVD Site-Isolated Deposition

## P-30 PVD



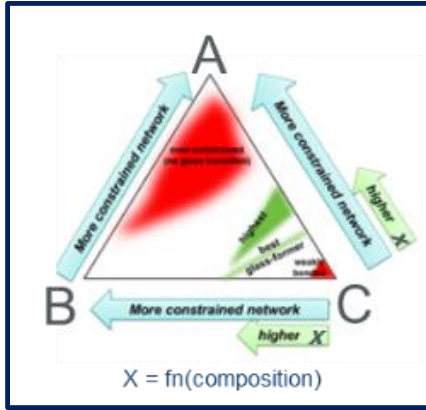
### Each site is an independent experiment

- Each layer can be deposited by 1 to 4 sputter sources
- Multiple layers can be deposited at one site
- Aperture: defines area where material is deposited; there is no intermixing of areas
- Shutters for Aperture and Target: prevents cross-contamination between layers & targets
- Recipe: includes target cleaning & conditioning before each deposition



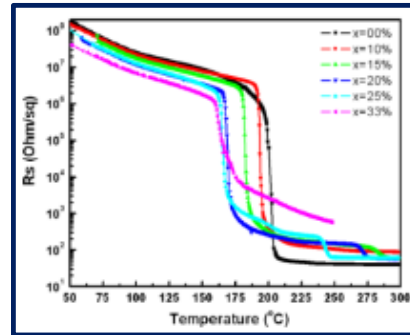
# IMI's NVM Screening Methodology

Material Understanding



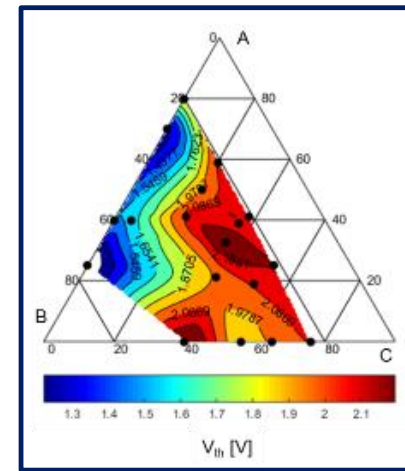
Define Compositional Space

Thermal Stability & Resistivity



Screen Materials

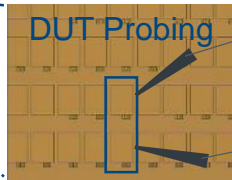
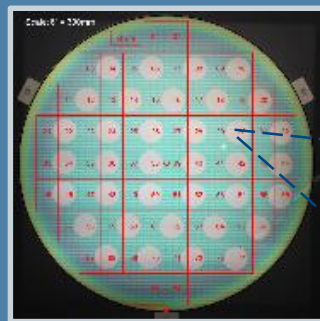
Composition



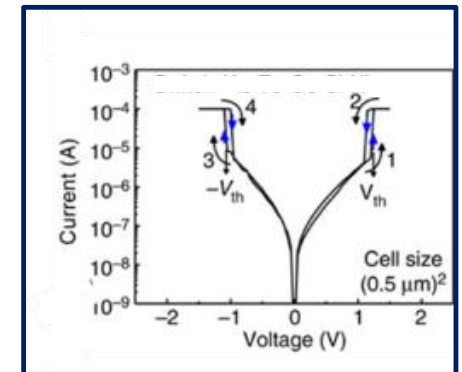
Select Promising Compositions

IMI P-30 PVD Chamber

300mm Dep & Test



Electrical/Reliability

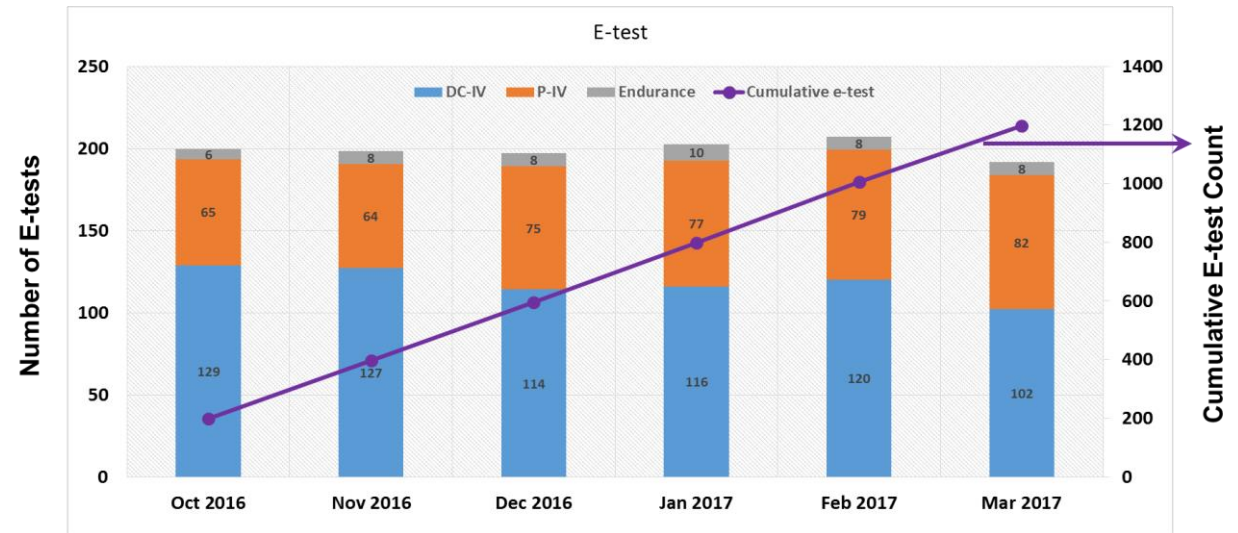
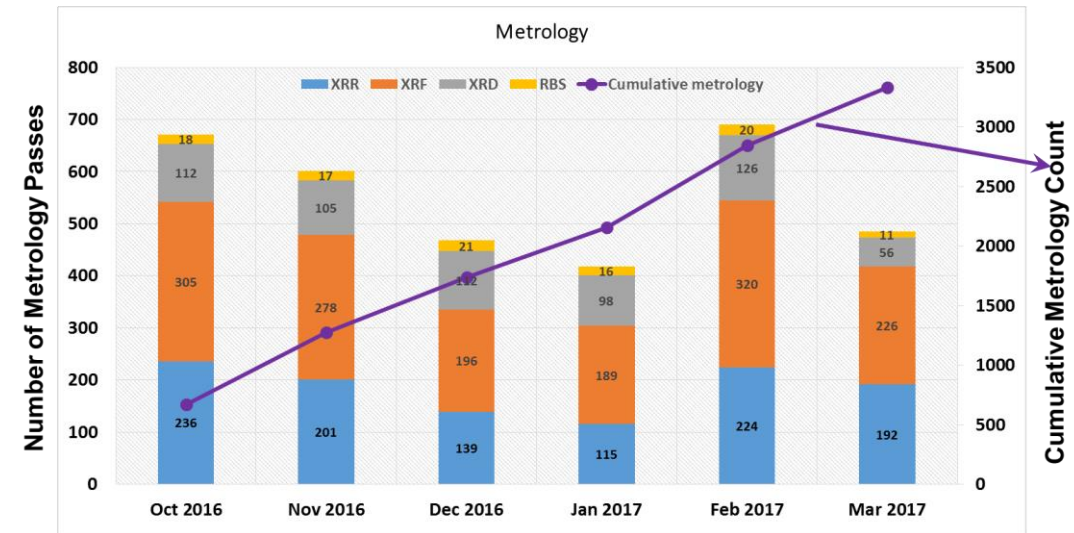
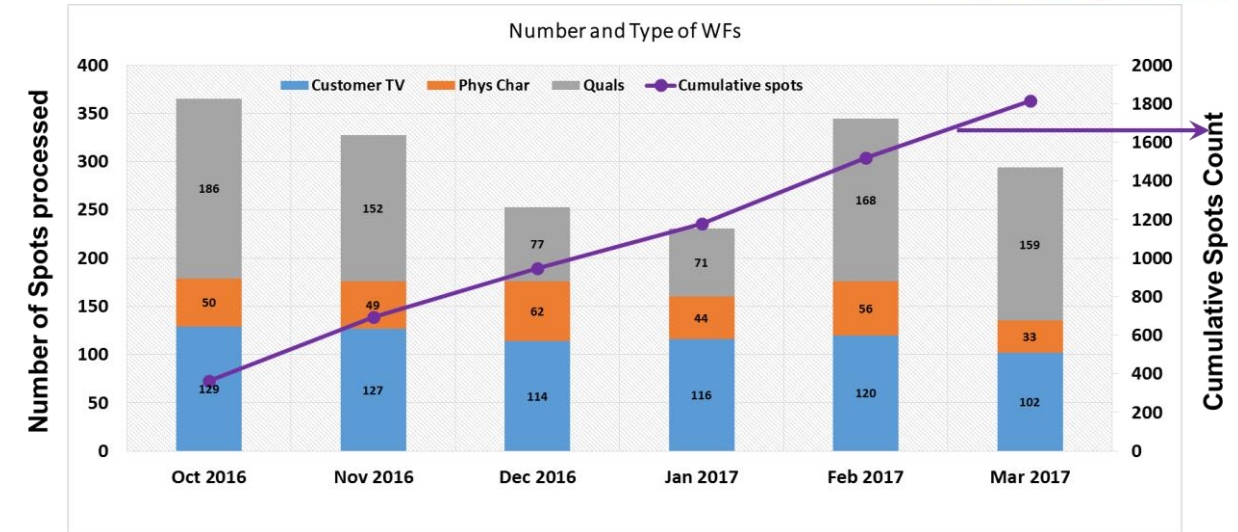
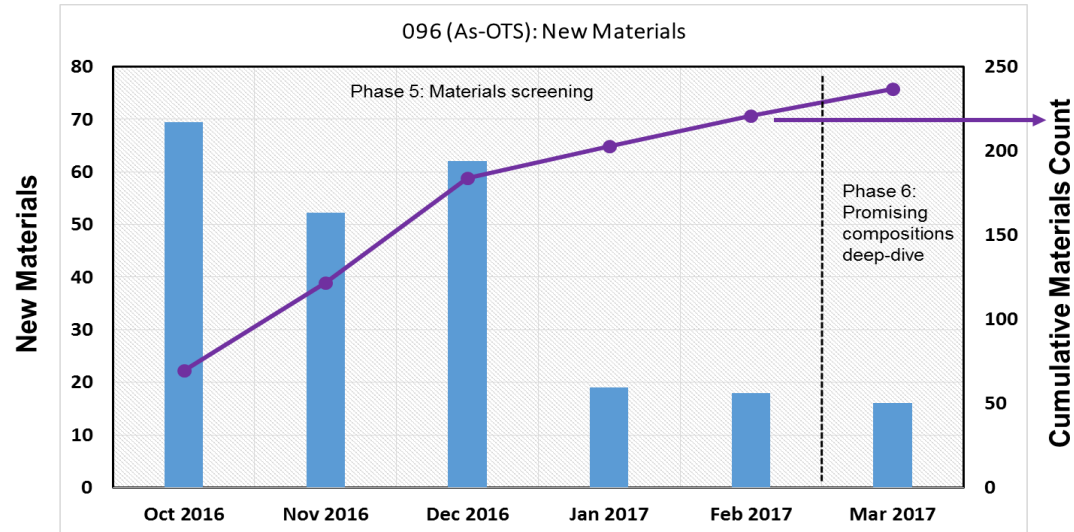


Converge on specs

Parameter	Key Results
Non-linearity	> 7 dec/V
Threshold Voltage	Tunable (1 to 5V)
Leakage ( $I_{off}$ )	< 1E-10 at 90nm
Switching time	< 10ns
Endurance	> 1E9 cycles

# Consistent/High Throughput Execution: A Development Accelerator

## 6 month Snapshot (Oct 1st - Mar 31st 2017)



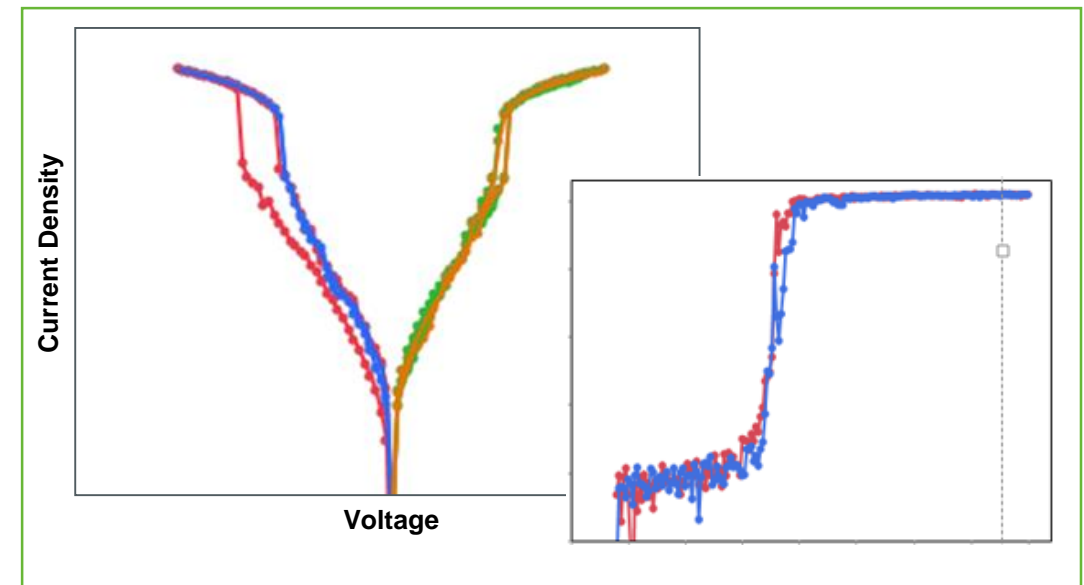
High Throughput Experimentation is the engine that enables and accelerates materials/compositions discovery for memory development

# Selector Programs — Key Results

Screened 1000's of MSM, MIEC and OTS compositions over 5 year period

- Selector behavior observed in several systems with different mechanisms
- Repeatable selector performance demonstrated
- Tunable threshold voltage
- Hyper-abrupt turn-on ( $> 7$  dec/V)
- $I_{\text{off}} < 1\text{E-}10$  at 90nm critical dimension
- Switching time  $< 10\text{ns}$
- Endurance  $> 1\text{E}9$  cycles
- Bipolar operation
- Thermal stability tunable with composition

Example DC-IV Sweeps



- ❑ Memory selector elements based on different material systems and physical mechanisms
- ❑ Customer and IMI teams have collaborated on achieving such challenging device goals
- ❑ Rapid learning with dep and test vehicle



